ETFO – Teachers Learning Together 2009-2010

Collaborative Action Research Project
Final Report

School Board: District School Board of Niagara
TLT Team: Susan DiTeodoro, Sharon Donders, Joy Kemp-Davidson, Peggy Robertson
University partners: Cathy Bruce and Tara Flynn

1.) Introduction

a. Description of team

The research team consisted of 4 teachers (two Gr. 2/3, one Gr. 2 and one Gr. 3), from 4 different schools in DSBN. We had already developed a strong sense of community and well-developed culture of teaching and learning collaboratively, as we had been math lead teachers for two years. We then participated in our board's professional learning initiative, SUM (Supporting Understanding in Mathematics), for three years. In 2008-2009 we took part in ETFO action research project TLT . We were supported in our research by Lori Schuyler and Glynnis Fleming, special assignment teachers in mathematics for DSBN, Cathy Bruce, professor at the School of Education at Trent University and her research assistant, Tara Flynn.

b. Problem description and context

Through discussion, we identified the following facets of the problem we wanted to focus on:

- Lack of depth of student understanding in mathematics
- Challenges around consolidation of the learning (big idea)
- Lack of student independence in tackling problems
- Find a balance between pre-planning and teacher flexibility during lesson

We believe the following factors contribute to the problem:

- Content knowledge we need to get students to the big idea
- An ability to ask good questions to get to the big idea
- Need for knowledgeable other (co-planning and co-teaching)
- The challenges of building a strong community of learners
- Students' developmental levels and understanding of mathematics
- Students' lack of prior experience asking questions in mathematics.

Goals

We want to see in students:
- Develop understanding of what a good question looks like
- Apply of good questions in mathematics
- Independently ask high quality questions of their peers to further develop mathematical understanding

We want to see in ourselves:
- Improved ability to ask probing questions that are meaningful
- Deepen student understanding of the mathematics through our questions
- Ability to use questions to make connections to previous learning

c. Research Question

How does a focus on questioning in mathematics affect teacher and student abilities to ask good questions during problem solving tasks?

2.) Research Process

a. Description of Interventions

As a team, we generally planned to:

1. Research questioning strategies;
2. Co-plan lessons;
3. Observe and record student and teacher questions.

Surface vs. Deeper Questions

We framed our analysis of the questions based on a reading called Questioning the Questions by Tienken, Goldberg and DiRocco (2009). The authors separated questions into categories called productive (provide students the opportunity to create, analyse or evaluate, these questions are usually open ended and divergent in nature) and reproductive questions (questions prompt students to imitate, recall or apply knowledge and information taught by the teacher, through a mimicked process). We decided to work with these categories but renamed them "surface" (reproductive) and "deeper" (productive), language that we felt would be more accessible to students. The article suggested that 50% or more of the questions asked in a lesson should be productive (deeper). The article also got us thinking about the value of preparing questions ahead of time: "Teachers, like lawyers, can prepare a list of questions prior to starting a lesson. …Question preparation guarantees that some questions will foster productive thinking." It is especially important to prepare some deeper questions ahead of time because "productive questions are more difficult to generate in the heat of the moment while teaching." The article drove home the point that "the practice of preparation is where

educators can benefit most." Based on this article, we chose 50% as our target for deeper questions.

After our first cycle of data collection and analysis (specifically, after analyzing the first set of student questions recorded during observations of our first problem), we decided that explicit teaching about questioning was needed. We adjusted our plan to include the following:

- teach surface and deeper questions
- give students 20 questions to sort
- generate criteria for surface/deeper questions with students
- create poster/anchor charts with students

Student sorting activity

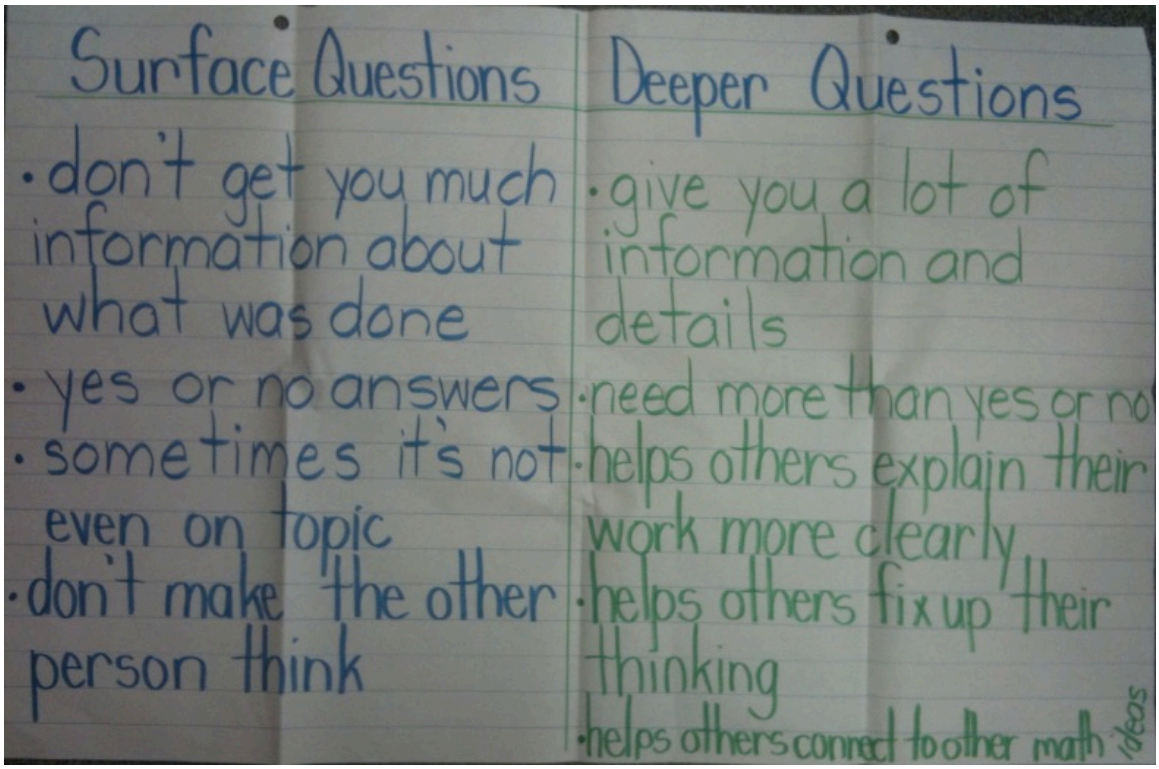
The following sample of questions (pulled from authentic teacher and student examples from the first round of data analysis) were given to the students to discuss. As a class, the students placed the questions on a t-chart labeled "surface" and "deeper". The class discussion was used to have the teacher draw out the criteria for good questioning.

Deeper questions used for the sorting activity	Surface questions used for the sorting activity
1. Why did you do it that way? 2. How did making a _____ help you? 3. Why does this strategy work for you? 4. Why did you split the numbers into groups? 5. Why did you use tallies? Did that strategy help you? 6. Did you draw the pictures first and then use them to help you? 7. Why did you put 6+6=12 and then 6+ 6=18? 8. How did showing your thinking this way help you to solve the problem? 9. What other math were you thinking of when you choose this way? 10. How could you show your thinking without having to write so much?	1. Why did you use tallies? 2. Why did you use 3's? 3. Was it hard or easy? 4. Why did you do squares? 5. Why do you think it is 42? 6. Why did you do it big and messy? 7. How fat is he? 8. Did you want to write in words how you got your answer? 9. Is there one bowl of cat food? 10. What did you do?

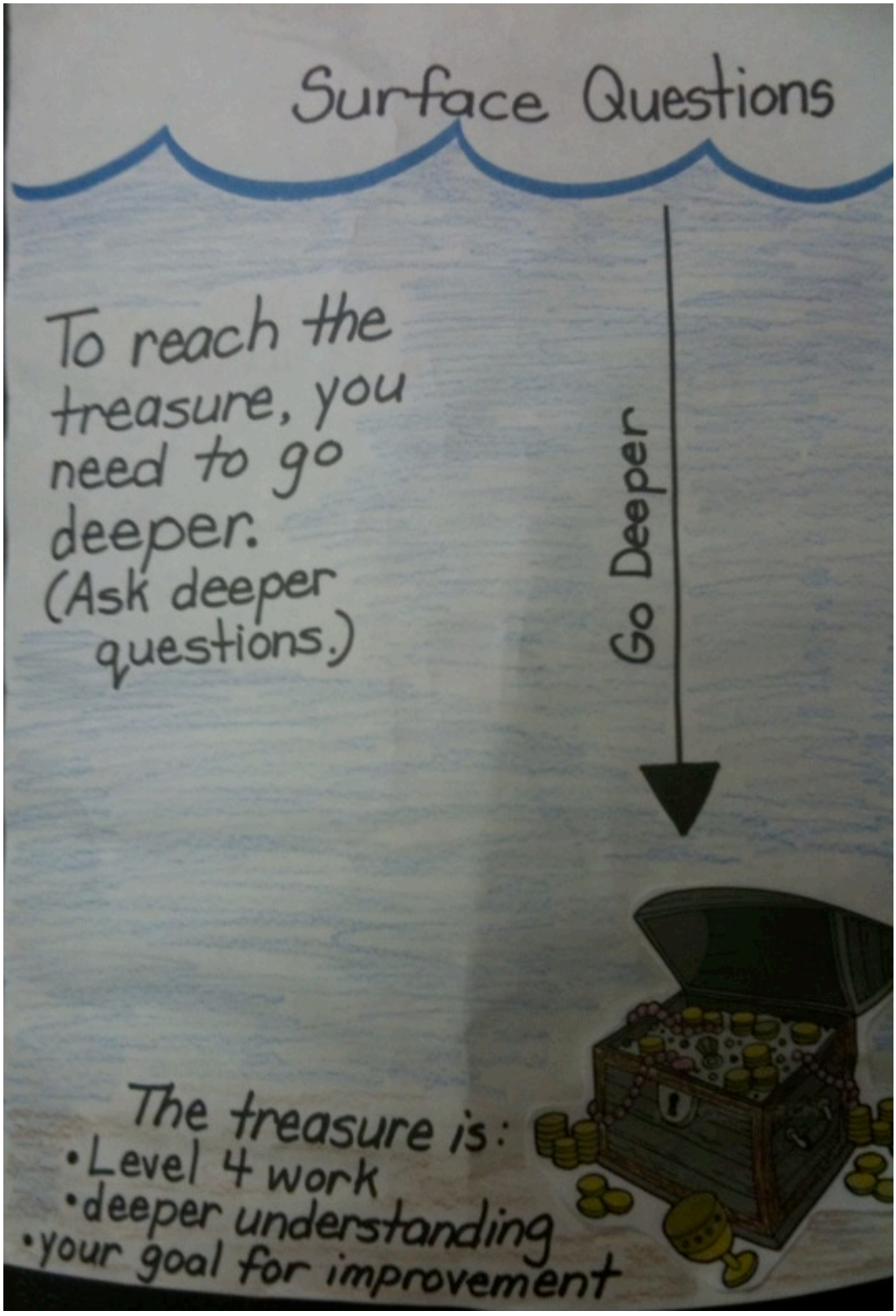
We developed a set of criteria for good questions as a team, which we drew out of the whole class discussions following the sorting activity with students:

A deeper question…
… causes the other person to give more detail.
… helps the person connect to other math they have learned.
… helps the other person fix up their thinking.
…requires someone to explain their math so you understand it better.
…requires more than a yes or no answer.

An example of a class-generated set of criteria for surface and deeper questions.



We also used these criteria to develop anchor charts to help students visualize where their questions were taking them.



Description of Team Activity

1. Six Dinner Sid by Inga Moore (lesson from Math and Literature by Marilyn Burns) given to all four classes as a pre – assessment:

- Gallery walk and congress
- Another research team member was present for each of the chosen problems and they recorded the questions as the classroom teacher was teaching
- Teacher questions were recorded during problem solving activity and student questions were recorded from gallery walk
- Met as a group and sorted teacher and student questions into surface, deeper and unclear
- Developed top ten surface and top ten deep questions for teacher and students
- Criteria for good questions anchor chart developed for use in classrooms
- Next focus problem was decided on – Two of Everything by Lily Toy Hong (lesson from Math and Literature by Marilyn Burns)

2. Explicit focus on questioning

- Each of the four classes sorted the previously selected questions with their students
- Whole class discussion of surface and deep questions followed from having students sort and think about the questions
- Each team member selected an article to summarize and share with the other members
- All four team members visited the classroom of a knowledgeable other to watch a problem solving lesson and record the questions asked (a teacher who's TLT team focused on questioning last year)

3. Two of Everything by Lily Toy Hong problem was given to all 4 classes

- Gallery walk and congress done as a whole class
- Teacher questions were recorded during problem solving activity and student questions were recorded from gallery walk
- Another research team member was present for each of the chosen problems and they recorded the questions as the classroom teacher was teaching
- Met as a group and sorted teacher and student questions into surface, deeper and unclear

4. One Grain of Rice (by Demi) problem was given to all four classes

- The same format of gallery walk, congress and question recording was followed
- The group members met and sorted questions into surface and deeper
- At this point the category "unclear" was no longer needed (we feel that as group members we were more confident at sorting the questions)

b. Data Collection Process

Question analysis:

- 3 times presented a common problem and then did a gallery walk to generate student questions (recorded on sticky notes)
- Team member observed during bansho/congress and recorded teacher and student questions
- We sorted the questions according to deeper/surface criteria
    - teacher questions were analyzed after all three problems
    - student questions were analyzed pre and post (the first and last problems only)

Teacher Journaling:

We used a journaling process in which we compared our individual observations, looking for commonalities to indicate overall learning.

Findings

In our initial sorting of the questions, we included an "unclear" category to deal with questions that didn't neatly fit into either category or in which the context was unclear. In the final analysis of teacher and student questions, we removed the 3rd category of unclear questions and sorted all questions into the two categories of surface and deeper. There are a few possible implications:

- As our understanding developed we were better able to define what we would consider deeper or surface – the criteria became more clear to us – and we were able to remove that category.
- This may also have been due to increased teacher confidence in identifying the types of questions, guided by the research article, Questioning Questions.
- There may have also been an increase in the overall quality of the questions and student and teacher understanding of types of questions and how to pose a question to get at the mathematics.

a. Student Findings

PRE (raw data):

Category	Totals	Percentages
Surface	52/97	54%
Deeper	16/97	16%
Unclear	29/97	30%

PRE ('unclear' questions removed)

Category	Totals	Percentages
Surface	52/68	76%
Deeper	16/68	24%

POST

Category	Totals	Percentages
Surface	70/234	30%
Deeper	164/234	70%

In our first point of data collection, most of the questions (76%) were surface level questions, with only 24% falling into the 'deeper' category. (We removed the unclear category from consideration in order to make a pre-post comparison.) By the second

point of data collection, a far greater percentage of student questions were deeper questions.

We also looked at the number of questions asked by students. These dramatically increased by the second point of data collection in the 3rd lesson. In the first problem, students asked 97 questions. In the 3rd lesson, 204 student questions were recorded. One explanation could be that student confidence in asking questions increased over the course of our work in the project. Students finally understood what was really expected of them in math and how to phrase questions. They also understood the purpose and importance of asking deeper questions in math.

b. ***Teacher Learning***

LESSON 1 (raw data):

Category	Totals	Percentages
Surface	51/97	53%
Deeper	17/97	17%
Unclear	29/97	30%

LESSON 1 ('unclear' questions removed)

Category	Totals	Percentages
Surface	51/68	75%
Deeper	17/68	25%

LESSON 2 (raw data):

Category	Totals	Percentages
Surface	52/122	43%
Deeper	49/122	40%
Unclear	21/122	17%

LESSON 2 ('unclear' questions removed)

Category	Totals	Percentages
Surface	52/101	51%
Deeper	49/101	49%

LESSON 3

Category	Totals	Percentages
Surface	51/163	31%
Deeper	112/163	69%

With each lesson, the percentage of deeper teacher questions increased. Our target was to reach 50% in the deeper question category and we hit 69%, well above target.

We anticipated that the number of questions we asked overall would decrease as we cut out the surface questions. This didn't bear out: just as with students, the number of teacher questions also increased. One possible explanation is that we became more deliberate in our posing of questions and actually asked more deeper questions overall. We also attribute this to a shift in our own understanding of what effective questioning looked like. The process of recording and analyzing/sorting the questions helped us to become more aware of the quality of our questions and we become more purposeful in our questioning. This process has helped us to begin to internalize what good questions are.

c. Overall Summary of Findings

Overall, both the quantity and quality of student questions increased. We believe this was due to explicit teaching and time for student practice.

At first we assumed that as we changed our practice and modeled effective questioning, that students would naturally start asking better questions. But as we were sorting and analyzing the student questions, we realized that student also needed to experience this critical process, so we created opportunities for students to sort and analyze their own questions and the questions of their peers. Our initial analysis of the questions was a critical turning point as we realized that we needed to make the students a part of the process. This process, of generating criteria for deeper and surface questions with students, presented important learning for us as well as for our students.

Students also took on a responsibility for asking good questions, as students took ownership over their learning and the learning of peers. They understood that questions were another avenue to better understanding.

Key Teacher Learnings

Through journaling and focused group discussion, we identified the following as key teacher learnings:

- Explicit teaching was important
- Richest student learning happens during consolidation (with deeper questions), seeing each other's work, making comparison and connections.
- Co-teaching is powerful
    - during observations, teachers were more aware of their questioning and value that experience.
    - Input from colleagues during congress provides other points of view into student thinking

- having other teachers in the room has given the support to try new things and high yield strategies: opportunity of "having a friend jump into the deep end with you"

- Student learning through focus on questioning happens for everyone (student asking the question, students answering the question and students listening). Focus was initially on the student learning happening while writing the questions, not on the student answering the question or the students who were listening

- Ownership of students over questions (eg. students really trying not to duplicate questions)

- We got to know our students in a different way, bringing them on board with teaching in a community of learners.

- Visual of the poster (diving deep for treasure) was powerful imagery for kids. That analogy helped teachers and kids to identify the goals of questioning.

- Kids also got better at analyzing the questions and being more discerning in their sorting of "unclear" questions.

- Questions that appear to be surface can stimulate deeper thinking.
  - sometimes questions appear to require 'yes' or 'no' answers, but the context is so important
  - we don't want to give the impression that surface questions are not valuable.
- Preplanning questions makes a huge difference

  - frees you cognitively to ask better questions in the moment
  - realized that effective questioning is a real art
  - Think more about the problems, the questions relating to the problems
  - People don't spend a lot of time thinking about questions ahead of time (we think about it after the lesson)
  - We are putting more thought into lessons again
  - One team member's reflects "One key to asking effective questions is knowing where you are going before you begin the lesson. If we are driving our cars, we wouldn't ever just pull away from the curb and hope we could figure out our destination as we went along. We would discuss with someone where we were going, look at a map or find the information on the Internet. The same thing should happen with our questioning. We should not take a "fly by the seat of your pants" approach. Although we want to be flexible and be able to respond in the moment, we need to spend some time ahead of our lessons to decide our

destination and the type of questions that will allow us to arrive on time and with an understanding of how we got there." (Teacher journal, June 2010)

- We learned a lot about the logistics of organizing the gallery walk that will inform how we approach these next year
- Focus on questioning heightened student awareness of importance of clear communication and increased the meta-cognition of students in their written work, because it emphasized: how do we communicate our thinking so others understand and *why* this is important. We feel that when students learn to question more effectively and respond more clearly, they will develop a better understanding of mathematical concepts.

5. Next Steps/New questions

- Start earlier in the year to focus on questions and incorporate it through the year.
- Gallery walk and bansho will be part of our practice next year. Now we know how to provide a framework for students to make Gallery Walk more effective.
- Explicit teaching of questioning (deeper and surface questions) will continue to be part of our math program next year.
- Allowing for positive comments as well as questions on different coloured sticky notes made it a more positive experience for students.
- We want to disseminate this work by sharing our learning with other teachers in our own schools. To do this, we will look for opportunities for co-teaching with staff members.
- Have students apply surface and deeper questions throughout their daily learning in all subject areas.

6. References (Relevant Literature and Resources)

Boaler, J., & Brodie, K. 2004). The importance, nature and impact of teacher questions. In D.E. McDougall, & J A. Ross (Eds.), *Proceedings of the twenty-sixth annual meeting of the North American Chapter of the International Group for Psychology of Mathematics Education - Volume 2* (pp. 773-782). Toronto, Ontario.

Craig, J., & Cairo III, L. (2005). Assessing the relationship between questioning and understanding to improve learning and thinking (QUILT) and student achievement in mathematics: A pilot study. Appalachia Educational Laboratory at Edvantia, Inc. Charleston, West Virginia.

Demi., 1997, One Grain of Rice: A Mathematical Folktale. Scholastic Press. New York City.

Hanna, C., Martinello, S., Mojeski, C., Redmond, G., & Milot, P. (2009). Student questioning in a problem solving context. Report from Year 2 of ETFO: Teachers Learning Together. District School Board of Niagara.

Herbel-Eisenmann, B., Drake, C., & Cirillo, M. (2009). 'Muddying the clear waters': Teachers' take-up of the linguistic idea of revoicing. Teaching and Teacher Education, 25.

Hong, Lily Toy. 1993. Two of Everything. Morton Grove, IL: Albert Whitman.

Milot, P. & Fleming, G. (2009). LNS-identified high yield instructional strategies in mathematics: Gallery Walk, Bansho, & Congress – Teacher Tips. Paper presented at OAME, Ottawa, Ontario.

Moore, Inga. 1991. Six-Dinner Sid. New York: Simon and Schuster Books for Learners.

Moschkovich, J. (2008). "I went by twos, he went by one": Multiple interpretations of inscriptions as resources for mathematical discussions. The Journal of the Learning Sciences, 17: 551-587.

National Council of Teachers of Mathematics. (2010). Asking good questions & promoting discourse. Online resource; accessed June 2010. Available at http://www.nctm.org/resources/content.aspx?id=25149

Tienken, C., Goldberg., S., & DiRocco, D. (2009). Questioning the Questions. Kappa Delta Pi Record, 46:1 (Fall).

Truxaw, Mary P., Gorgievski, Nicholas, DeFranco, Thomas C. (2008). Measuring K-8 teachers' perceptions of discourse use in their mathematics classes. *School Science and Mathematics,* February, 01.